T.E. (Mechanical) (Semester – II) Examination, 2010
REFRIGERATION AND AIR CONDITIONING
(2003 Course)

Time : 3 Hours Max. Marks : 100

Instructions : *1) Answer **any three** questions from **each** Section.*
*2) Answers to the **two** Sections should be written in **separate** books.*
*3) **Neat** diagrams must be drawn **wherever** necessary.*
*4) Black figures to the **right** indicate **full** marks.*
*5) **Use** of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is **allowed**.*
*6) Assume **suitable** data, **if necessary**.*

SECTION – I

Unit – 1

1. a) Define refrigeration and explain how it can be achieved by satisfying second law of thermodynamics. **4**

   b) List different methods/processes used in refrigeration and explain pulse jet refrigeration with figure. **6**

   c) A refrigerator works on reversed Carnot cycle between –5°C and 20°C. Calculate power required to drive refrigerator to produce 1000 kg ice per hour at –5°C from water at 20°C.

   Take C_{pw} = 4.186 kJ/kg K, C_{pi} = 2.1 kJ/kgK, and latent heat of fusion of ice 330 kJ/kg. **6**

OR

2. a) List the reasons for carrying out air conditioning in aeroplanes. 3

   b) Discuss advantages and disadvantages of using air as refrigerant. 3

   c) A Bell Coleman refrigerator of 10 TR capacity operates between 1 and 7 bar. Air temperature at inlet of compressor and expander are 15°C and 37°C respectively. Both compression and expansion indices are 1.3. Compressor and expander have stroke length of 40 c.m. and speed 350 rpm, both single acting, with volumetric efficiency 85%. Find :

      1) Mass of air circulated per min
      2) C.O.P.
      3) Cylinder diameters of compressor and expander. 10

Unit – 2

3. a) Discuss effects of superheating vapours and subcosting liquid separately on performance of vapour compression cycle. 6

   b) A vapour compression cycle using R12 operates between –20°C and 35°C. The liquid refrigerant is sub cooled to 30°C. The vapour leaving evaporator is dry saturated. Assuming isentropic compression and heat rejection rate in condenser is 13.42 MJ/min. Calculate :

      1) Refrigerating effect in kJ/kg.
      2) Capacity in TR.
      3) Compressor Power.
      4) C.O.P. 10

R12 properties $C_{pv} = 1.235$ kJ/kg K.

Temp. °C	Specific Enthalpy kJ/kg		Specific Entropy KJ/kgK	
	h_f	h_{fg}	s_f	s_g
-20	17.82	160.91	0.0731	0.7087
+30	64.59	135.03	0.2400	0.6853
+35	69.56	131.89	0.2559	0.6839

OR

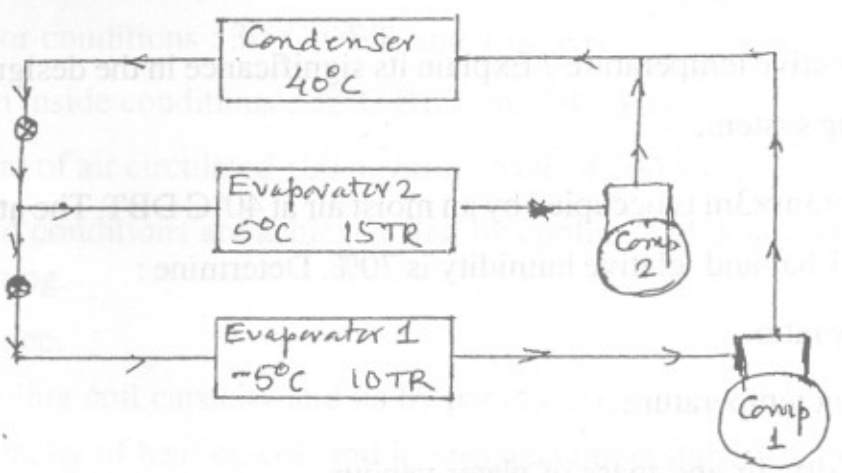
4. a) Explain the terms :
   i) O.D.P.
   ii) G.W.P. and
   iii) TEWI. **6**

   b) A 10 TR vapour compression cycle plant with R12 refrigerant operates between condensing and evaporation temperatures as 40°C and –10°C respectively. The vapours entering compressor are superheated by 5°C. Calculate for isentropic compression.
   i) refrigerating effect/kg
   ii) mass flow rate of refrigerant per second
   iii) compressor power if its mechanical efficiency is 85%
   iv) volume handled by compressor in m^3/sec (You use P-h chart provided). **10**

Unit – 3

5. a) Explain a two stage vapour compression cycle with flash intercoder. List its advantages. **8**

   b) Fig. no. 1 shows multi evaporator system using freon 12 refrigerant. Calculate :
   i) Mass flow rate of refrigerant in each evaporator.
   ii) Power required to run the system.
   iii) C.O.P. Take vapour entering each compressor dry saturated. **10**



5.(b) Fig. 1

OR

6. a) Explain construction, working of practical NH_3- water vapour absorption system. 6

b) Compare VCC and VAC. 6

c) In an ammonia water vapour absorption system of refrigeration heat is supplied in generator by steam at 2 bar and 90% dry. Temperature maintained in refrigerator is –5°C and atmosphere temperature is 30°C. Find maximum possible C.O.P. If capacity of plant is 20TR and actual COP is 70% of maximum C.O.P., find steam requirement per hour. 6

SECTION – II

Unit – 4

7. a) Define the following:
   i) Humidity ratio.
   ii) Dew point temperature.
   iii) Degree of saturation. 6

b) What is effective temperature ? Explain its significance in the design of air conditioning system. 4

c) A room 6m×3m×3m is occupied by an moist air at 40°C DBT. The atmospheric pressure is 1 bar and relative humidity is 70%. Determine :
   i) humidity ratio
   ii) dew point temperature
   iii) mass of dry air and mass of water vapour. 6

OR

8. a) Explain different psychrometric processes which are carried with the help of air washer. **4**

   b) 200 kg/h of air saturated at 2°C is mixed with 40 kg/h of air at 30°C and 55% RH. Determine the final state of air. **4**

   c) 3 kg/s of air at 20°C DBT and 19°C DPT enters a heating coil and humidifying apparatus, from which it leaves at 35°C DBT and 28°C DPT. Moisture is supplied as liquid water at 25°C to humidity the air. Find the total quantity of heat and moisture that must be added through the apparatus. Draw the process on psychrometric chart. **8**

Unit – 5

9. a) What is humidistat ? **4**

   b) Write a note on 'All Air conditioning system'. **6**

   c) Describe any two expansion devices used in refrigeration system. **6**

OR

10. a) Define : SHF, ADP and GSHF. **4**

    b) What is infiltration load and ventilation load ? **4**

    c) In an air conditioning system following are the details.

    Outdoor conditions : 30°C DBT, and 75% RH.

    Design inside conditions : 22°C DBT and 70% RH.

    Amount of air circulated 100 m^3/min ; ADP of coil 14°C.

    Desired conditions are achieved first by cooling and dehumidifying and then by heating.

    Determine:

    1) Cooling coil capacity and its by pass factor.
    2) Capacity of heating coil and its surface temperature if its by pass factor is 0.35.
    3) Amount of water removed by dehumidification per hour. **6**

Unit – 6

11. a) A rectangular duct, 800 mm ×550 mm size carries 5 m^3/s of air having density 1.15 kg/m^3. Determine equivalent diameter of circular duct if

    a) air flow is same.

    b) air velocity is same.

    Further find pressure loss per 100 m for f = 0.001. Also calculate total pressure required at inlet to the duct to maintain the same flow, and air power required. **8**

    b) Explain equal friction or static regain method of duct design giving its advantages and disadvantages. **4**

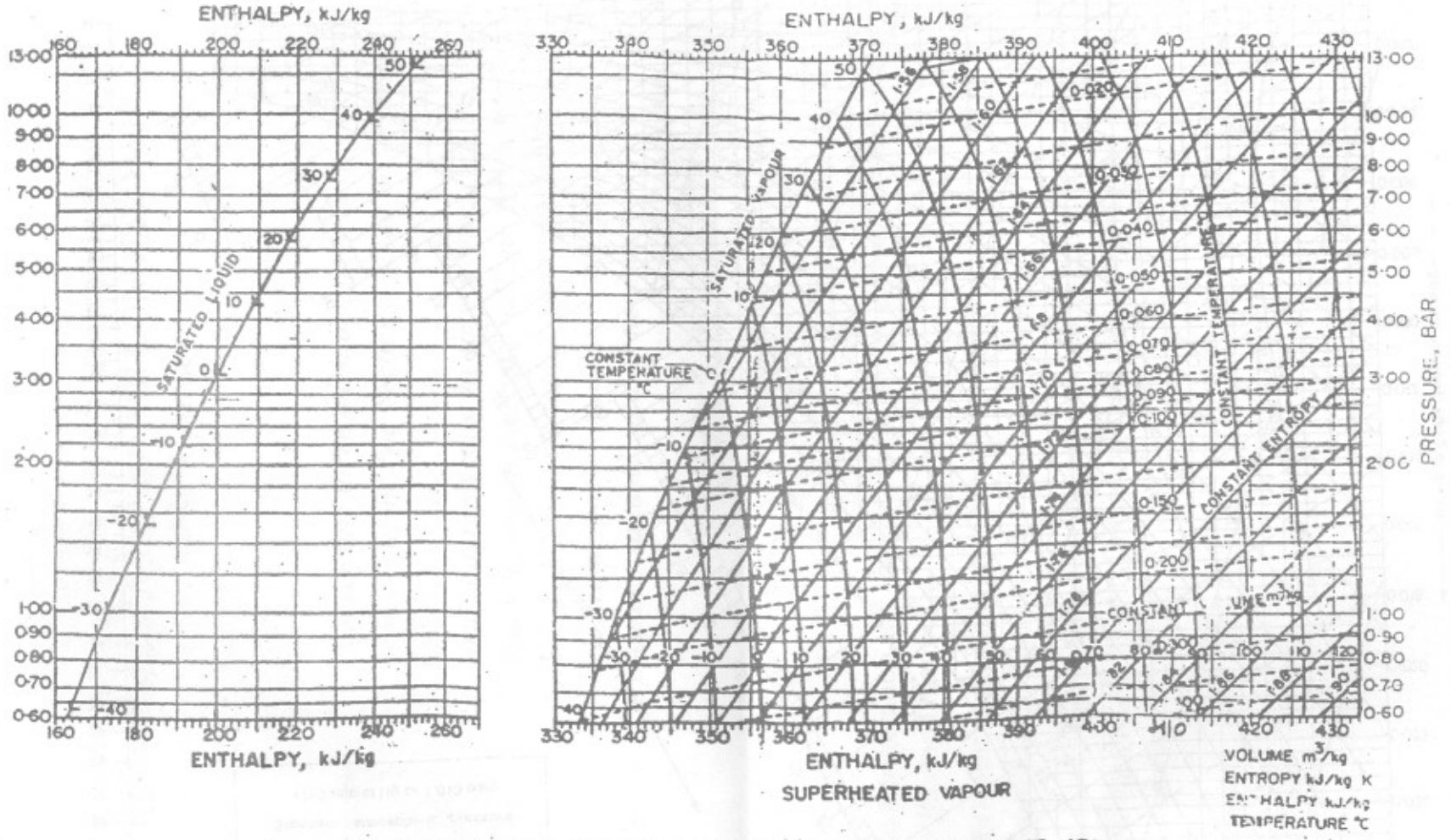
    c) Explain factors responsible for the spoilage of the food and vegetable products. **6**

OR

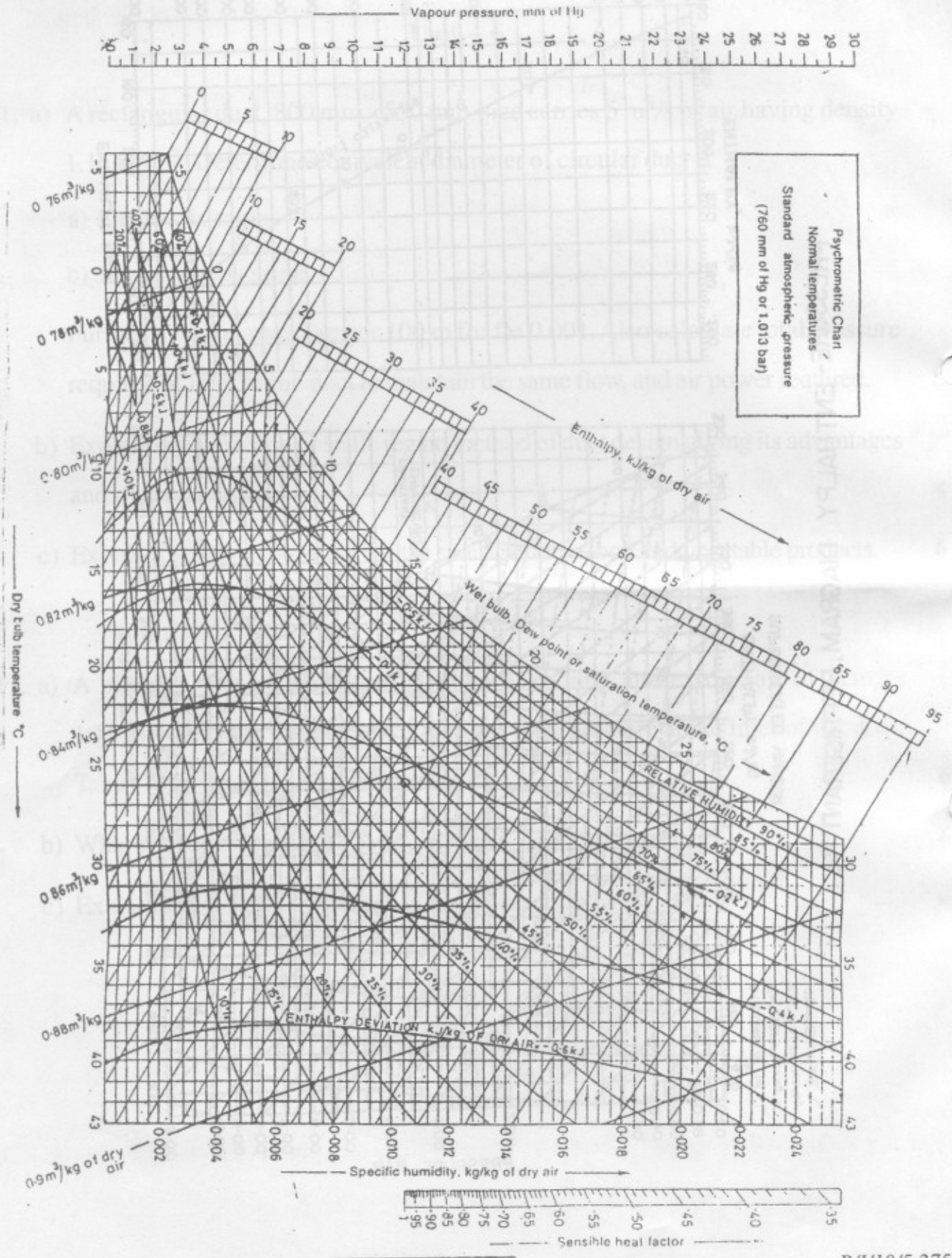
12. a) A circular duct of diameter 0.3 m is 50 m long and carries air of density 1.15 kg/m^3. If the flow is 2 m^3/s find the total pressure at the inlet of the duct. Take f = 0.006. Also find air power. **6**

    b) What is friction chart ? Discuss its use in duct sizing. **6**

    c) Explain the different methods of food preservation. **6**



PRESSURE-ENTHALPY DIAGRAM, REFRIGERANT 12


Vapour pressure, mm of Hg
Psychrometric Chart
Normal temperatures
Standard atmospheric pressure
(760 mm of Hg or 1.013 bar)
Enthalpy, kJ/kg of dry air
Wet bulb, Dew point or saturation temperature, °C
Dry bulb temperature °C
RELATIVE HUMIDITY
ENTHALPY DEVIATION kJ/kg OF DRY AIR
Specific humidity, kg/kg of dry air
Sensible heat factor
0·76m³/kg
0·78m³/kg
0·80m³/kg
0·82m³/kg
0·84m³/kg
0·86m³/kg
0·88m³/kg
0·9m³/kg of dry air

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